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HUES OF THE SPECTRUM COLORS

The characteristic appearance of the visible spectrum is a series of chromatic colors varying from dim red through orange, yellow, brilliant yellow-green, green, blue, to dim violet. The brightest part of the normal equal-energy spectrum under usual observing conditions is at 555 millimicrons (yellowish green), and from this point toward both longer and shorter wave lengths the brightness progressively diminishes.

If color differences due to variation in brightness are left out of account, there still remain more than one thousand parts of the spectrum which can be distinguished by hue and saturation alone under suitable observing conditions. An appreciable part of these one thousand distinguishable steps is ascribable to saturation difference. For example, spectrum red is a much more saturated color than spectrum yellow, and there are many more steps between spectrum yellow and spectrum red than there are between spectrum yellow and a red color of the same saturation; a considerable part of the difference between spectrum red and spectrum yellow is, therefore, a difference in saturation. The part of the spectrum having the least saturated color is at 570 millimicrons (greenish yellow)

Strictly speaking, the appearance of the spectrum is variable depending chiefly on the following factors which will be discussed in turn:

1. Color Vision of the Observer. To the totally color blind observer, the spectrum appears as a band of achromatic light varying from very dim at one end through a maximum brilliance near the center back to very dim at the other end; it exhibits no hue whatsoever. To the observer who has inherited partial color blindness (red-green blindness), the spectrum exhibits only two hues; it consists of a long-wave band appearing yellow and of a short-wave band appearing blue, the two bands being separated by an achromatic or neutral point. To the normal observer, the spectrum appears as indicated above, but such observers disagree somewhat in their descriptions of the spectrum and there is reason to believe that the appearance of the spectrum varies slightly from one normal observer to another.

2. Size and Location of the Retinal Region Stimulated. Portions of the normal retina moderately distant from the center (point of most distinct vision) frequently respond as if red-green blind; the extreme periphery under ordinary conditions is totally color blind.

3. Retinal Illumination. If the spectrum is very weak so that the retina receives only twilight illumination, its appearance will be the same to the normal as to the totally color blind observer. If the spectrum is very strong so as to be dazzling, it likewise exhibits no hue. Just weaker than the dazzle stage, it appears predominantly yellow and blue, and just stronger than the twilight stage, it appears predominantly red, green, and violet. At intermediate retinal illuminations, it takes on the characteristic appearance, but the appearance depends on the particular illumination.

4. Pre-exposure Stimulus. The spectrum looks different to a dark adapted eye than to a light adapted; to a red adapted eye than to a green, and so on.

In the work to be summarized, the observers were either presumed to be normal or found by test not to be seriously anomalous; they looked directly at the spectrum so that a region near the center of the retina was used; the spectrum was neither too weak nor too strong to prohibit the characteristic appearance, and the pre-exposure stimulus was darkness, sunlight, overcast-sky light, or some other stimulus which was presumed not to introduce chromatic fatigue. Within these limits various observing conditions were used. The lack of agreement is to be ascribed to these variations, to individual differences between the observers, and to the usual experimental error which prevents an observer from duplicating his results exactly even though observing conditions are identical.

The following table gives the wave lengths corresponding to red, orange, yellow, green, blue, and violet, and their intermediates according to various authorities. The entries have been arranged chronologically. The average values given are equally-weighted arithmetical means. No average wave length for red is given because some of the authorities state that pure red is not to be found in the spectrum, spectrum red being reported as slightly orange. For the same reason no maximum value of wave length for red could be given, nor any average or minimum values for violet.

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Authority	Date	Wave Length in Millimicrons										
		Red	R-O	Orange	O-Y	Yellow	Y-G	Green	G-B	Blue	B-V	Violet
Helmholtz	1866	687	656					527			431	
Bezold	1874		656		589	578	558	532	502	468	432	
Donders	1884					582		535		485		
Rood	1890	700	621	597	588	581		527	502	473	438	406
Voeste	1902					577		498		476		
v. Kries	1907					574		503				
Westphal	1909					574		506		479		
Dreher	1911					575		509		477		
Ridgway	1912	644		598		577		520		473		410
Goldytsch	1916									468		
Bradley	1920	656		608		579		514		469		421
Goldmann	1922					568		504		468		
Priest	1926	680				583		515		475		
Brückner	1927					578		498		471		
Shubert	1928					574		500		467		
Weld	1932		622		597		577		492		456	
Gage	1933		625		600							
Verbeek	1935		605	598	587	580	569	530	496			
Maximum			656	608	600	583	577	535	502	485	456	421
Average			631	600	592	577	568	515	498	473	439	
Minimum		644	605	597	587	568	558	498	492	467	431	